NAVY EXPERIMENTAL DIVING UNIT

REPORT NO. 4-88

EVALUATION OF READY OPERATIONAL PIERSIDE EMERGENCY REPAIR (ROPER) DIVING CART

H. L. PRUITT, JR.

JULY 1988

NAVY EXPERIMENTAL DIVING UNIT

DEPARTMENT OF THE NAVY
NAVY EXPERIMENTAL DIVING UNIT
PANAMA CITY, FLORIDA 32407-5001

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NAVSEA Task 87-37

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In 1987 NEDU evaluated the Ready Operational Pierside Emergency Repair (ROPER) Diving Cart. Both manned and unmanned tests were conducted. The purpose of the test and evaluation was to determine the ROPER Diving Cart's suitability for fleet use. The evaluation revealed several minor discrepancies deserving correction prior to fleet use. The evaluation also found two major discrepancies with the ROPER Diving Cart. First, the cart is presently configured to support only two divers (one in water and one standby). Many underwater ship husbandry/repair diving evolutions require two men in the water. The

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second major discrepancy is the 60 FSW depth limitation which is only imposed by the operating instructions. Many near pierside depths exceed 60 FSW. The cart has the capability to satisfy both the pressure and volumetric requirements of supporting three divers in the water on all no-decompression dives save those of long durations encountered in shallow depths.

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ABBREVIATIONS

FSW	feet of seawater
HP	high pressure
LP	low pressure
NEDU	Navy Experimental Diving Unit

ABSTRACT

In 1987 NEDU evaluated the Ready Operational Pierside Emergency Repair (ROPER) Diving Cart. Both manned and unmanned tests were conducted. The purpose of the test and evaluation was to determine the ROPER Diving Cart's suitability for fleet use. The evaluation revealed several minor discrepancies deserving correction prior to fleet use. The evaluation also found two major discrepancies with the ROPER Diving Cart. First, the cart is presently configured to support only two divers (one in water and one standby). Many underwater ship husbandry/repair diving evolutions require two men in the water. The second major discrepancy is the 60 FSW depth limitation which is only imposed by the operating instructions. Many near pier side depths exceed 60 FSW. The cart has the capability to satisfy both the pressure and volumetric requirements of supporting three divers in the water on all no-decompression dives save those of long durations encountered in shallow depths.

KEY WORDS:

Diving Equipment
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I. INTRODUCTION

The Ready Operational Pierside Emergency Repair (ROPER) Diving Cart was developed to fulfill the need for a mobile, readily deployable, self-contained diving system capable of supporting the dive tasks of ship repair activities.

The Navy Experimental Diving Unit (NEDU) was tasked to test and evaluate a first article production unit of the newly redesigned ROPER Diving Cart, NAVSEA Task 87-37. Test and evaluation was conducted to determine its suitability for fleet use and capability to meet the requirements of supporting two, one in water and one standby, (SSDS MK 12, MK 1 MOD 0, ESDS (AGA), and Superlite 17B/NS) divers to 60 feet for 60 minutes. This report is a summary of NEDU's findings.

II. FUNCTIONAL DESCRIPTION OF ROPER CART

The following is a brief description of the major components of the ROPER Diving Cart (Figure 1) and their functions:

A. TRAILER

The diving system is permanently mounted on a trailer which is approximately 16 feet long by 7 feet wide. The trailer transports the diving system and 1,000 pounds of additional equipment.

B. COMPRESSED AIR FLASKS

The divers' primary air supply is stored in two 6-cubic-foot, 3,000-pounds per square inch gage (psig) rated air flasks (MIL-F-22606B, Type GF, Service B). The secondary (emergency) air supply is stored in a 1.5-cubic-foot, 5,000-psig rated air flask (MIL-F-22606B, Type GF, Service B). The ROPER Diving Cart design is based upon a maximum working pressure of 3,000 psig for all three flasks.

C. CART CHARGING STATION

The system's air flasks are charged from a suitable (external) high pressure source via the cart's charging station.

D. CONTROL CONSOLE

The control console permits a single operator to control and monitor the supply of air to the divers and to handle diver communications.

E. DIVER'S INTERFACE PANELS

Each of the two diver's interface panels provides the necessary connections to supply air to and a pneumofathometer connection for one diver.

F. SCUBA CHARGING STATION

The ROPER Diving Cart is also equipped with a SCUBA charging station which can be used to charge SCUBA bottles with air furnished from the cart's primary air supply.

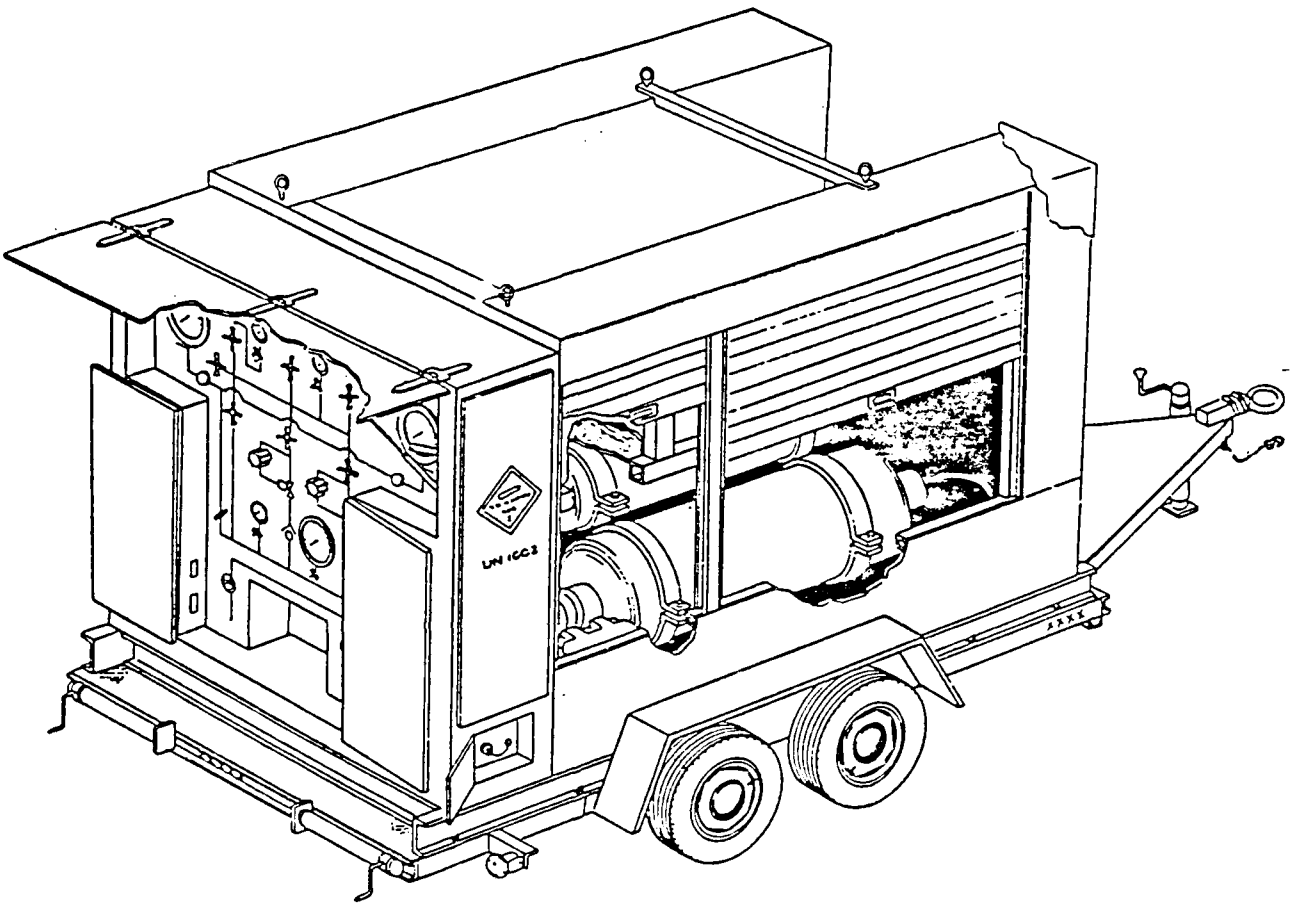

FIGURE 1 ROPER Diving Cart.

III. TEST AND EVALUATION PROCEDURES

Test and evaluation procedures were previously established by NEDU[1] for both the manned and unmanned evaluation of the ROPER Diving Cart.

Unmanned testing consisted of a technical review of the Operational and Emergency Procedures provided, a concurrent road handling endurance and system tightness test, a flow test, and a subjective design engineering and human factors evaluation.

Manned testing consisted of using the ROPER Diving Cart to support Superlite 17B/NS, ESDS (AGA), and MK 12 dives to 60 FSW concurrent with the execution of operational and emergency procedures.

IV. TEST AND EVALUATION RESULTS AND DISCUSSION

A. OPERATIONAL AND EMERGENCY PROCEDURES (OPS/EPS)

Operating Procedures (OPs) and Emergency Procedures (EPs), with maximum time motion efficiency, are provided in Appendixes A through I. The OPs and EPs were validated by diagrammatic review of operational testing and found to be procedurally correct. During evaluation dives using two MK 12 divers in the swimmers mode at 60 FSW, EP-2, EP-3, and EP-4 were able to be executed quickly and with little effect on manifold pressure (Table 1). It is also noted that the control panel operator was able to adequately regulate pressure on the regulator bypass (AHP-9) while divers were ventilating. The team was composed of six divers as per Table 2. Both the diving supervisor and the control panel/communications operator found the ROPER Diving Cart adequate to support surface supplied no-decompression diving operations.

B. ROAD PERFORMANCE TEST

The ROPER Diving Cart on five occasions was driven a minimum of 100 but no more than 140 miles on various road and traffic conditions (i.e. city roads and traffic, improved highways, and dirt roads). All drivers' comments were positive as to the carts towing and backing characteristics. Concurrent with each day's 100 mile road performance test, a pressure tightness test on both the high pressure and low pressure sides of the system were conducted. No measurable losses in pressure were discovered. Following each road performance test, full scale gage comparisons indicated that the gages installed remained in calibration in spite of exposure to arduous road conditions.

C. FLOW TEST

A MK 12 helmet requires 80 psig at the console for diving at 60 FSW with a 600 foot umbilical in order to provide a flow of 6 ACFM. The ROPER Diving Cart was able to provide a flow of 221 scfm under these conditions, or 78.4 ACFM. Thus flow rate is not a limiting factor for one, two, or three divers.

Table 1

ROPER Diving Cart Emergency Procedure Execution Data

Emergency Procedure (EP)	Execution Time (Seconds)	Manifold Pressure (psig)		
		Minimum Measured	Required	Maximum Measured
EP-2 Loss of primary high pressure air supplies	25	80	80	80
EP-3 Primary air reducer fails	22	73	80	86
EP-4 Secondary air reducer fails	30	70	80	80
Vent of divers on regulator bypass (EP-4 in effect)	N/A	76	80	90

Table 2

ROPER Diving Cart Manning Level During Test and Evaluation

Watch Station	Manning Level
Diving Supervisor	1
Diver	2
Tender	2
Control Panel Operator/Communications	1
TOTAL	6

D. DESIGN ENGINEERING AND HUMAN FACTORS EVALUATION

Symbols used in NAVSEA Drawing No. 6182284 "ROPER Diving Cart Piping Schematic" (see Figure 2) conform to a most liberal interpretation of MIL-STD-17B-1. ALP-1, ALP-2, ALP-5, AHP-5, AHP-6, and AHP-14 are gage calibration stop valves fitted with calibration ports and functionally different from the remaining needle valves, yet to this end the drawing is silent. The symbols used for the regulators, the check valves, and relief valves are either inconsistent with MIL-STD-17B-1, the majority of drawings of diver's life support systems and/or the components installed or those called for on the fabrication drawings.

The axes of the flasks presently installed are not parallel to the frame of the cart and thus do not line in the horizontal plane. This orientation allows condensation to pocket under the dip tube in the lower end of the flasks, as such, condensation can not be adequately bled down.

There is an absence of pad eyes in various locations on the diving cart. Pad eyes are needed on the main frame for the purpose of securing the cart to a floating platform. Pad eyes are needed for hose strain reliefs at the charging stations and the diver interface enclosures. Pad eyes are also needed to tie down gear stored in the open storage area.

Fittings for SCUBA charging are mounted on the SCUBA charging panel. A similar panel is needed for the system charging fittings.

Navy safety publications require that operating instructions be posted on all equipment to prevent injury to personnel and damage to equipment. Selected items from OP-4 should be posted on the cart in accordance with section 602h of General Specifications for U.S. ships as operating instructions.

All air, primary as well as emergency, must pass through the ½-Inch Pipe Manifold Assembly, Air Control Panel, NAVSEA drawing number 6182302, a single component. This design is tantamount to having high pressure primary and emergency air passing through a single pipe. Failure of the manifold which is bound by valves AHP-1, AHP-2, AHP-3, AHP-4, AHP-7, AHP-8, and AHP-9 as depicted in Figures 2 and 3 will result in either the uncontrolled depressurization of the system or the securing of all air leaving only that in the volume tank for service to the divers. This type of arrangement is not in conformance with present certification policy. Figure 4 provides an arrangement with no additional valves that will permit a failure of the manifold to be isolated and bypassed thereby ensuring air is provided to the divers.

Fabrication documentation, test sheets, clean sheets, welder qualifications, etc. were thoroughly reviewed and found to be complete and well organized.

The ROPER Diving Cart's human factors were evaluated with regard to standardized criterion[2]. The cart was found to be satisfactory in all

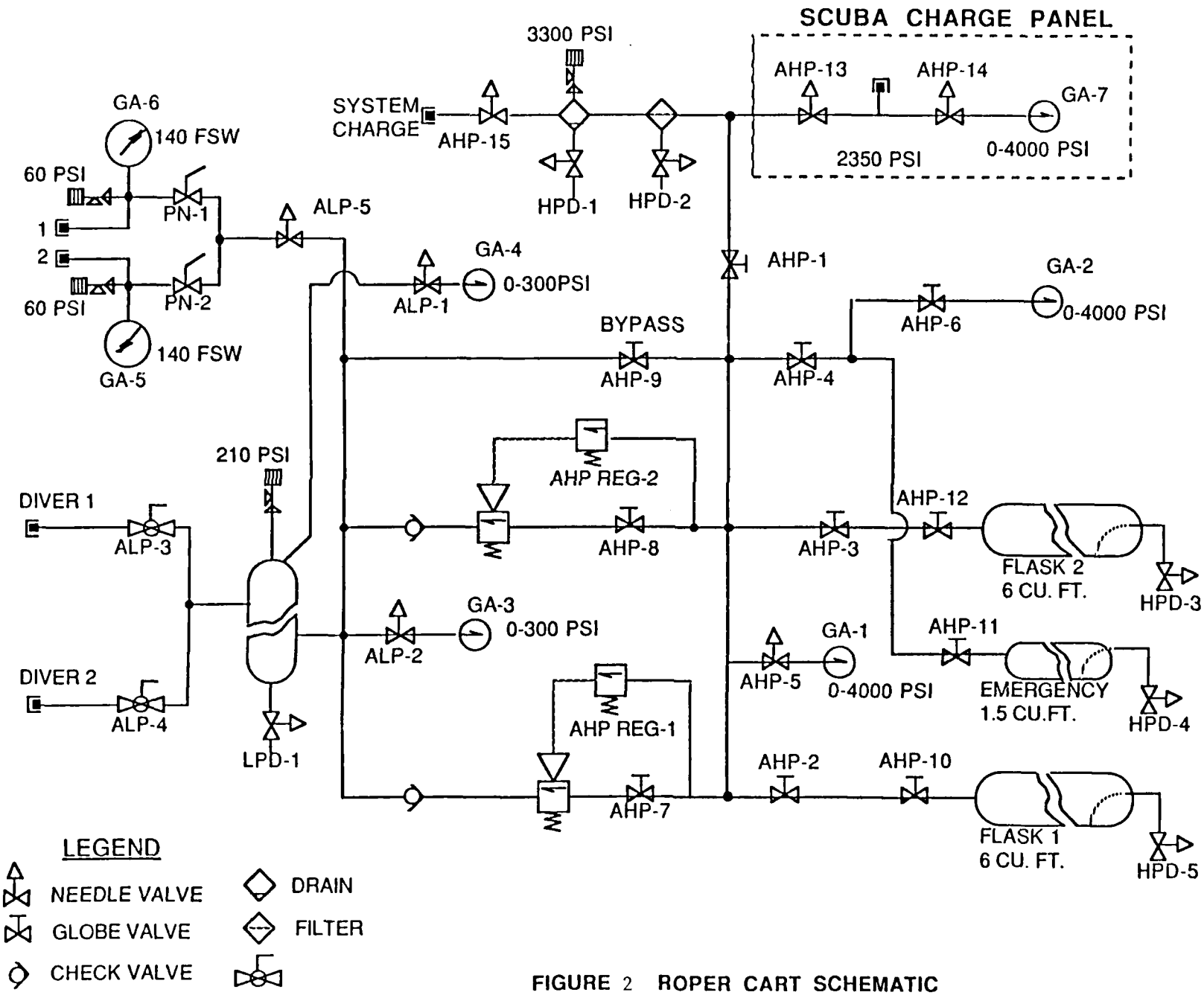

FIGURE 2 ROPER CART SCHEMATIC

ROPER CART HP MANIFOLD SCHEMATIC

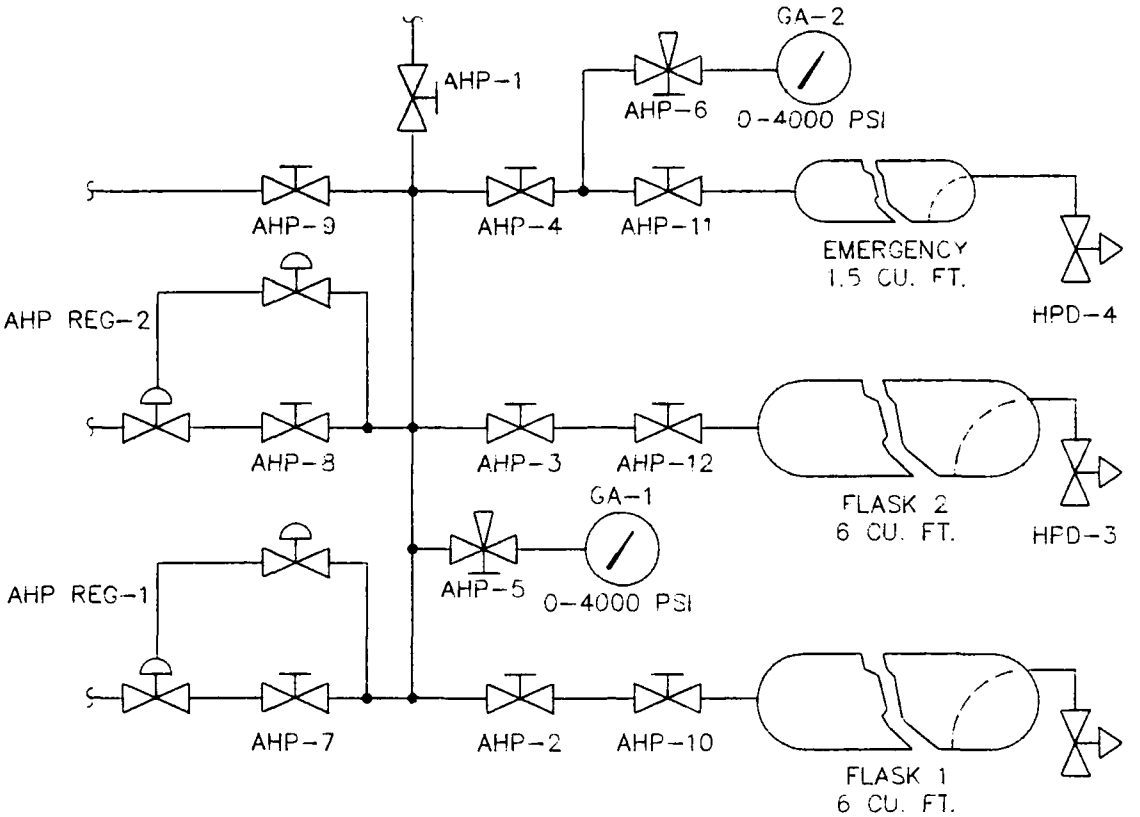

FIGURE 3 EXISTING

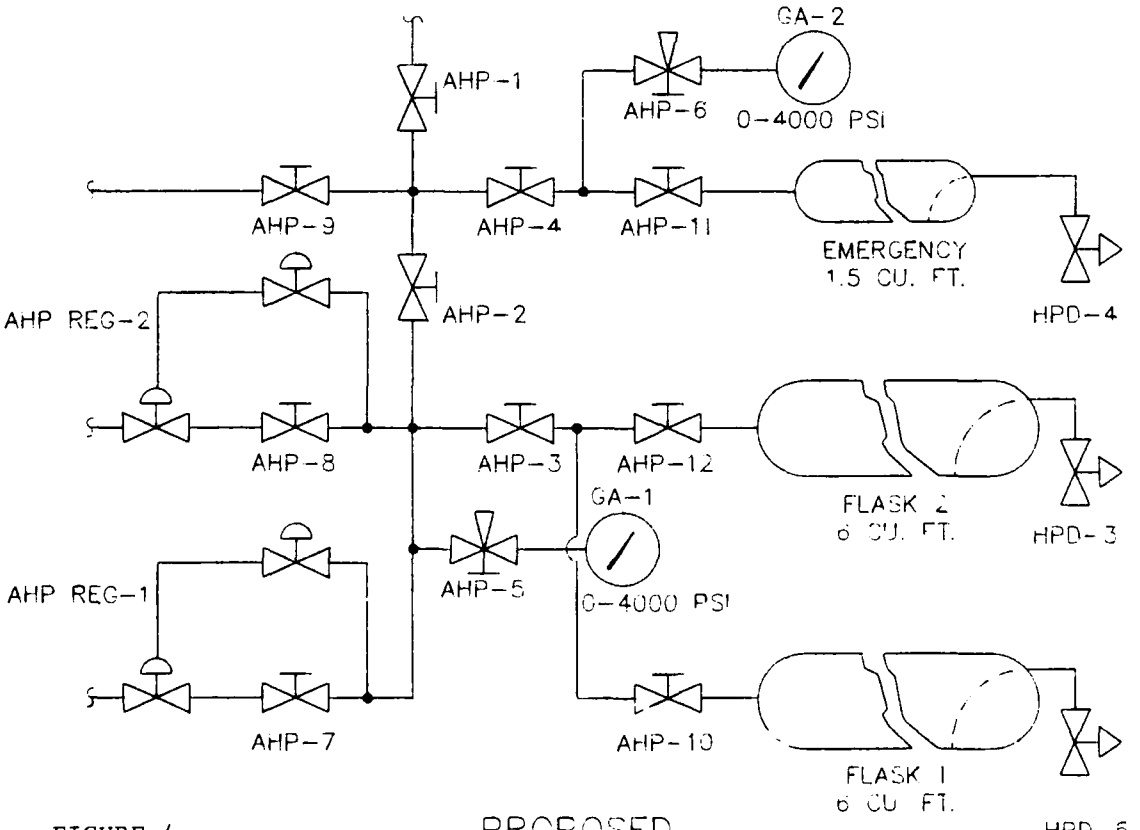

FIGURE 4 PROPOSED

respects except for those areas which are discussed in the remainder of this section.

- The overbottom pressure gages are not in close relationship with the hand loaders. Rectification may be too costly.

- The flow diagramatic on the panel is not clearly legible. Painting the diagramatic in black will rectify this discrepancy.

- The volume tank pressure gage ALP-1 and the LP line pressure gage ALP-2 are not separated by any valves or other air processing components. They will always read identical pressures and are therefore redundant. It is recommended that one of the two gages be removed.

- The axes of the depth gages normal to gage faces are in the horizontal plane, and as they are mounted high on the control panel, accurate reading is impossible for all but the tallest of operators. The faces of the gages should be angled down.

- Valves on the flasks (AHP-10, AHP-11, AHP-12, HPD-3, HPD-4, and HPD-5) and the volume tank LPD-1 do not meet the anthropomorphic standards for reach and as such are difficult to operate. Rectification will require extensive piping modification and may not be practical.

- The pneumofathometer valves PN-1 and PN-2 are not situated in a position commensurate with their frequency of use. Rectification by placing the valves closer together and closer to the pneumo gages may not be practical.

- Diver gages and controls should be color coded by functional grouping.

- The pneumofathometer depth gage scale markings are in increments of 0.4 FSW, making depth reading difficult.

- The emergency flask valve AHP-11 is mounted upside down. It should be rotated 90° so that the axis of the valve stem is in the horizontal plane.

- The emergency flask and valve should be clearly and distinctly marked.

- Numerous hand wheels obscure labels.

- The diver interface enclosures are too small to accommodate standard air wrenches. Thus special tools are required to connect the divers umbilicals to the diving cart. An alternative arrangement that will relieve the necessity for special tools should be explored.

- The access doors to the various stations and storage compartments are of three different types and presently require a minimum of three different keys. Door locking devices should utilize one type of lock that will require the use of a single master key.

- The latches on the diver interface enclosures are extremely difficult to operate and are prone to damage.

- Doors to the control panel should be equipped with positive locking mechanisms to ensure once fully opened they will remain so.

- The doors to the control panel should be equipped with a fold down writing surface for the keeping of diving logs.

- The electrical outlet cover interferes with the operation of ALP-3. The electrical outlet should be relocated or an alternate hand wheel fitted to the valve.

- Hose storage space is inadequate, increased storage space for divers umbilicals should be investigated.

V. CONCLUSIONS AND RECOMMENDATIONS

The ROPER Diving Cart in its present configuration has a number of discrepancies. When these are corrected the cart will be adequate and suitable for fleet use. The difficiencies noted in Section IV should be rectified by appropriate Engineering Change Proposals and/or revisions to existing or proposed software. Rectifying these discrepancies will enhance the ROPER Diving Cart's acceptability and ensure its fullest employment. Listed below are specific deficiencies.

A. NUMBER OF DIVERS

As it is desirable to have two divers in the water for all but the most simple of underwater ships husbandry and repair tasks, the cart must be modified to supply two divers and one standby diver. As the primary flasks in the present configuration can support in excess of 15 diver-hours at 60 FSW when using demand breathing systems, the only requirement is to modify the diver's and pneumofathometer hose connection/sub-systems.

B. DEPTH

Though a depth limit of 55 FSW (reference 3 requires 5 FSW be added to the depth measured by the pneumofathometer) is marginally adequate to perform underwater ships husbandry and repair tasks on all ships of the U.S. Navy it is an unnecessary and unwarranted restriction imposed only by the operating instructions and not limitations inherent to the equipment. A diver supported by a ROPER Diving Cart who drops a tool in waters deeper than 55 FSW will find himself having to return to the surface and have the tool recovered by another or himself donned in SCUBA gear. Numerous U.S. Navy ports are found to have

near pierside depths in excess of 55 FSW. The ROPER Diving Cart is capable of providing the manifold pressures required to support demand breathing systems to depths in excess of 140 FSW. The ROPER Diving Cart is capable of providing the air volumes required to support three steady flow divers at all depths for all no-decompression durations, except those shallower than 60 FSW and longer than 60 minutes. The depth restriction of 60 FSW should be removed. ROPER Diving Carts should be certified for all no-decompression dives, within volumetric limits, to the maximum depths required for diving pierside at the commands to which ROPER Diving Carts are issued, not to exceed 140 FSW.

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VI. REFERENCES

1. Navy Experimental Diving Unit Standard Test Plan Ready Operational Pierside Emergency Repair (ROPER) Diving Cart, NEDU Test Plan 87-23

2. MIL-STD-1472C, Human Engineering Design Criteria for Military Systems, Equipment and Facilities

3. U.S. Navy Diving Manual, NAVSEA 0994-LP-001-9010, Revision 1, 1 June 1985

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APPENDIX A

ROPER DIVING CART
OPERATIONAL PROCEDURES

OP-1: FLASK AND EMERGENCY CYLINDER PRESSURE CHECK AND CHARGING

ITEM	COMPONENT	DESCRIPTION	PROCEDURE	LOCATION	CHECK
1	AHP-1	CHARGING	SHUT	CONTROL PANEL	
2	AHP-4	EMERGENCY FLASK SUPPLY	SHUT	CONTROL PANEL	
3	AHP-9	REGULATOR BYPASS	SHUT	CONTROL PANEL	
4	AHP-8	REDUCER 2 INLET	SHUT	CONTROL PANEL	
5	AHP-7	REDUCER 1 INLET	SHUT	CONTROL PANEL	
6	AHP-3	FLASK 2 SUPPLY	OPEN	CONTROL PANEL	
7	AHP-2	FLASK 1 SUPPLY	OPEN	CONTROL PANEL	
8	AHP-5	SUPPLY FLASK GAGE STOP	VERIFY OPEN	CONTROL PANEL	
9	AHP-6	EMERGENCY GAGE STOP	VERIFY OPEN	CONTROL PANEL	
10	AHP-12	FLASK 2 SHUT OFF	OPEN	FLASK	
11	AHP-11	EMERGENCY FLASK SHUT OFF	OPEN	FLASK	
12	AHP-10	FLASK 1 SHUT OFF	OPEN	FLASK	

RECORD MAIN BANK PRESSURE ON GAGE GA-1 _____ PSIG

RECORD EMERGENCY FLASK PRESSURE ON GAGE GA-2 _____ PSIG

ITEM	COMPONENT	DESCRIPTION	PROCEDURE	LOCATION	CHECK
IF FLASKS DO NOT REQUIRE CHARGING GO TO ITEM 26. IF FLASKS REQUIRE CHARGING CONTINUE.					
WARNING: HIGH PRESSURE AIR SOURCE MUST BE CERTIFIED FOR DIVERS BREATHING AIR AND MEET ALL REQUIREMENTS OF U.S. NAVY DIVERS MANUAL, NAVSEA 0994-LP-001-9010					
WARNING: REMOVE DIVERS FROM THE WATER PRIOR TO CHARGING FLASKS.					
WARNING: 3000 PSIG MAXIMUM CHARGING PRESSURE.					
13	CONNECT CHARGING HOSE FROM HIGH PRESSURE SOURCE TO ROPER CART				
14	AHP-13	SCUBA CHARGING	SHUT	CHARGING STATION	
15	HPD-1	SEPARATOR DRAIN	SHUT	CHARGING STATION	
16	HPD-2	FILTER DRAIN	SHUT	CHARGING STATION	
17	AHP-15	CHARGING SUPPLY	OPEN	CHARGING STATION	
18	AHP-1	CHARGING	OPEN SLOWLY	CONTROL PANEL	
19	AHP-4	EMERGENCY FLASK SUPPLY	OPEN SLOWLY	CONTROL PANEL	
WHEN PRESSURE ON GAGE, GA-2 REACHES THE DESIRED VALUE CONTINUE.					
20	AHP-1	CHARGING	SHUT	CONTROL PANEL	
RECORD MAIN BANK PRESSURE ON GAGE GA-1 _____ PSIG					
RECORD EMERGENCY FLASK PRESSURE ON GAGE GA-2 _____ PSIG					
21	SHUT OFF HP AIR AT SOURCE.				

ITEM	COMPONENT	DESCRIPTION	PROCEDURE	LOCATION	CHECK
22	HPD-1	SEPARATOR DRAIN	OPEN	CHARGING STATION	
23	ALLOW CHARGING HOSE AND CART CHARGING SYSTEM TO BLEED DOWN.				
24	DISCONNECT CHARGING HOSE FROM CHARGING PANEL.				
25	HPD-1	SEPARATOR DRAIN	SHUT	CHARGING STATION	
26	AHP-15	CHARGING SUPPLY	SHUT	CHARGING STATION	
CAREFULLY BLEED DOWN MOISTURE IN FLASKS.					
27	HPD-3	FLASK 2 DRAIN	OPEN/SHUT	FLASK	
28	HPD-4	EMERGENCY FLASK DRAIN	OPEN/SHUT	FLASK	
29	HPD-5	FLASK 1 DRAIN	OPEN/SHUT	FLASK	
30	AHP-10	FLASK 1 SHUT OFF	SHUT	FLASK	
31	AHP-11	EMERGENCY FLASK SHUT OFF	SHUT	FLASK	
32	AHP-12	FLASK 2 SHUT OFF	SHUT	FLASK	
33	AHP-4	EMERGENCY FLASK SUPPLY	SHUT	CONTROL PANEL	
34	AHP-3	FLASK 2 SUPPLY	SHUT	CONTROL PANEL	
35	AHP-2	FLASK 1 SUPPLY	SHUT	CONTROL PANEL	

- END OF PROCEDURE -

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APPENDIX B

ROPER DIVING CART
OPERATIONAL PROCEDURES

OP-2: PREDIVE AND POSTDIVE OPERATING PROCEDURES

ITEM	COMPONENT	DESCRIPTION	PROCEDURE	LOCATION	CHECK
STEP 1 PREDIVE					
REDUCER PRESSURE SETTING SHALL BE PROVIDED BY DIVING SUPERVISOR _____ PSIG (200 PSIG MAX)					
1	AHP-1	CHARGING	SHUT	CONTROL PANEL	
2	AHP-4	EMERGENCY FLASK SUPPLY	SHUT	CONTROL PANEL	
3	AHP-9	REGULATOR BYPASS	SHUT	CONTROL PANEL	
4	AHP-8	REDUCER 2 INLET	SHUT	CONTROL PANEL	
5	AHP-7	REDUCER 1 INLET	SHUT	CONTROL PANEL	
6	ALP-3	DIVER 1 SUPPLY	SHUT	CONTROL PANEL	
7	ALP-4	DIVER 2 SUPPLY	SHUT	CONTROL PANEL	
8	PN-1	DIVER 1 PNEUMO	SHUT	CONTROL PANEL	
9	PN-2	DIVER 2 PNEUMO	SHUT	CONTROL PANEL	
10	AHP-5	SUPPLY FLASK GAGE STOP	VERIFY OPEN	CONTROL PANEL	
11	AHP-6	EMERGENCY GAGE STOP	VERIFY OPEN	CONTROL PANEL	
12	ALP-1	DIVER SUPPLY PRESSURE GAGE STOP	VERIFY OPEN	CONTROL PANEL	

ITEM	COMPONENT	DESCRIPTION	PROCEDURE	LOCATION	CHECK
13	ALP-2	DIVER SUPPLY LINE PRESSURE GAGE STOP	VERIFY OPEN	CONTROL PANEL	
14	ALP-5	PNEUMO SUPPLY	VERIFY OPEN	CONTROL PANEL	
15	AHP-2	FLASK 1 SUPPLY	OPEN SLOWLY	CONTROL PANEL	
16	AHP-3	FLASK 2 SUPPLY	OPEN SLOWLY	CONTROL PANEL	
17	AHP-12	FLASK 2 SHUT OFF	OPEN SLOWLY	FLASK	
CAREFULLY BLEED DOWN MOISTURE IN FLASKS.					
18	HPD-3	FLASK 2 DRAIN	OPEN/SHUT	FLASK	
19	HPD-4	EMERGENCY FLASK DRAIN	OPEN/SHUT	FLASK	
20	HPD-5	FLASK 1 DRAIN	OPEN/SHUT	FLASK	
21	AHP-11	EMERGENCY FLASK SHUT OFF	OPEN SLOWLY	FLASK	
	AHP-10	FLASK 1 SHUT OFF	OPEN SLOWLY	FLASK	
CAREFULLY BLEED DOWN MOISTURE FROM VOLUME TANK.					
23	LPD-1	VOLUME TANK DRAIN	OPEN/SHUT	VOLUME TANK	
RECORD MAIN BANK PRESSURE ON GAGE GA-1 _____ PSIG					
RECORD EMERGENCY FLASK PRESSURE ON GAGE GA-2 _____ PSIG					
24	AHP-REG-1	REGULATOR 1	BACK OFF	CONTROL PANEL	
25	AHP-REG-2	REGULATOR 2	BACK OFF	CONTROL PANEL	

ITEM	COMPONENT	DESCRIPTION	PROCEDURE	LOCATION	CHECK
VENT LP SYSTEM UNTIL GA-4 INDICATES AT LEAST 25 PSI BELOW PRESCRIBED MANIFOLD PRESSURE FOR THE DIVE (SEE OP-2 STEP 1).					
26	ALP-3	DIVER 1 SUPPLY	OPEN/SHUT	CONTROL PANEL	
27	AHP-7	REDUCER 1 INLET	OPEN	CONTROL PANEL	
ADJUST REGULATOR TO PRESCRIBED PRESSURE ON GAGE GA-4 _____ PSIG.					
28	AHP-REG-1	REGULATOR 1	REGULATE	CONTROL PANEL	
29	AHP-7	REDUCER 1 INLET	SHUT	CONTROL PANEL	
30	ALP-3	DIVER 1 SUPPLY	OPEN/SHUT	CONTROL PANEL	
VENT LP SYSTEM UNTIL GA-4 INDICATES AT LEAST A 25 PSI BELOW PRESCRIBED MANIFOLD PRESSURE FOR THE DIVE.					
31	AHP-8	REDUCER 2 INLET	OPEN	CONTROL PANEL	
ADJUST REGULATOR TO PRESCRIBED PRESSURE ON GAUGE GA-4 _____ PSIG.					
32	AHP-REG-2	REGULATOR 2	REGULATE	CONTROL PANEL	
IF IT IS AN EVEN CALENDAR DAY OF THE MONTH, GO TO ITEM #36.					
33	AHP-8	REDUCER 2 INLET	SHUT	CONTROL PANEL	
34	AHP-7	REDUCER 1 INLET	OPEN	CONTROL PANEL	

ITEM	COMPONENT	DESCRIPTION	PROCEDURE	LOCATION	CHECK
35	PLACE "IN USE" ON FOLLOWING VALVES: AHP-2, AHP-3, AHP-7. PLACE "STANDBY" ON FOLLOWING VALVES: AHP-4, AHP-9, AHP-8. GO TO ITEM #37.				
36	PLACE "IN USE" ON FOLLOWING VALVES: AHP-2, AHP-3, AHP-8. PLACE "STANDBY" ON FOLLOWING VALVES: AHP-4, AHP-9, AHP-7.				
37	CONNECT DIVER'S UMBILICALS TO DIVER 1 AND 2 SUPPLY.				
WHEN AIR IS REQUIRED TO DIVERS.					
38	ALP-3	DIVER 1 SUPPLY	OPEN	CONTROL PANEL	
39	ALP-4	DIVER 2 SUPPLY	OPEN	CONTROL PANEL	
ADJUST PRESSURE AS NECESSARY UNTIL GAGE GA-4 INDICATES THE DESIRED PRESSURE BY REGULATING THE IN-USE REGULATOR.					
STEP 2 POSTDIVE					
40	ALP-3	DIVER 1 SUPPLY	SHUT	CONTROL PANEL	
41	ALP-4	DIVER 2 SUPPLY	SHUT	CONTROL PANEL	
42	PN-1	DIVER 1 PNEUMO	SHUT	CONTROL PANEL	
43	PN-2	DIVER 2 PNEUMO	SHUT	CONTROL PANEL	
44	AHP-1	CHARGING	SHUT	CONTROL PANEL	
45	AHP-9	REGULATOR BYPASS	SHUT	CONTROL PANEL	

ITEM	COMPONENT	DESCRIPTION	PROCEDURE	LOCATION	CHECK
46	AHP-4	EMERGENCY FLASK SUPPLY	SHUT	CONTROL PANEL	
47	AHP-8	REDUCER 2 INLET	SHUT	CONTROL PANEL	
48	AHP-3	FLASK 2 SUPPLY	SHUT	CONTROL PANEL	
49	AHP-7	REDUCER 1 INLET	SHUT	CONTROL PANEL	
50	AHP-2	FLASK 1 SUPPLY	SHUT	CONTROL PANEL	
51	AHP-12	FLASK 2 SHUT OFF	SHUT	FLASK	
52	AHP-11	EMERGENCY FLASK SHUT OFF	SHUT	FLASK	
53	AHP-10	FLASK 1 SHUT OFF	SHUT	FLASK	
BLEED DOWN MOISTURE FROM VOLUME TANK.					
54	LPD-1	VOLUME TANK DRAIN	OPEN/SHUT	VOLUME TANK	
55	BLEED DOWN UMBILICALS AT DIVER HATS. DISCONNECT UMBILICAL CAP SUPPLY FITTINGS.				

- END OF PROCEDURE -

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APPENDIX C

ROPER DIVING CART
OPERATIONAL PROCEDURES

OP-3: SCUBA CHARGING

ITEM	COMPONENT	DESCRIPTION	PROCEDURE	LOCATION	CHECK
WARNING: TO AVOID UNNECESSARY RISKS, NEVER ATTEMPT TO CHARGE SCUBA TANKS WHILE DIVERS ARE IN THE WATER.					
NOTE: CHARGE SCUBA CYLINDER IN ACCORDANCE WITH U.S. NAVY DIVING MANUAL (NAVSEA 0994-LP-001-9010).					
1	AHP-13	SCUBA CHARGING	SHUT	CHARGING STATION	
2	AHP-14	SCUBA GAGE STOP	VERIFY OPEN	CHARGING STATION	
3	HPD-1	SEPARATOR DRAIN	SHUT	CHARGING STATION	
4	HPD-2	FILTER DRAIN	SHUT	CHARGING STATION	
5	AHP-7	REDUCER 1 INLET	SHUT	CONTROL PANEL	
6	AHP-8	REDUCER 2 INLET	SHUT	CONTROL PANEL	
7	AHP-9	REGULATOR BYPASS	SHUT	CONTROL PANEL	
8	AHP-4	EMERGENCY FLASK SUPPLY	SHUT	CONTROL PANEL	
9	AHP-1	CHARGING	OPEN SLOWLY	CONTROL PANEL	
10	AHP-3	FLASK 2 SUPPLY	OPEN SLOWLY	CONTROL PANEL	
11	AHP-2	FLASK 1 SUPPLY	OPEN SLOWLY	CONTROL PANEL	
12	AHP-10	FLASK 1 SHUT OFF	OPEN SLOWLY	FLASK	

ITEM	COMPONENT	DESCRIPTION	PROCEDURE	LOCATION	CHECK
13	AHP-12	FLASK 2 SHUT OFF	OPEN SLOWLY	FLASK	
14	CONNECT SCUBA CYLINDER TO BE CHARGED TO CHARGING YOKE				
15	SHUT CHARGING YOKE VENT VALVE.				
16	SHUT CHARGING YOKE SUPPLY VALVE.				
17	PLACE SCUBA RESERVE HANDLE IN "DOWN" POSITION.				
18	ENSURE CHARGING WHIP STRAIN RELIEF IS CONNECTED TO TRAILER AND CYLINDER.				
19	OPEN CHARGING YOKE SUPPLY VALVE.				
RECORD SCUBA CHARGING PRESSURE ON GAGE GA-7 _____ PSIG.					
WARNING: DO NOT EXCEED WORKING PRESSURE OF SCUBA CYLINDER.					
20	AHP-13	SCUBA CHARGING	OPEN SLOWLY	CHARGING STATION	
21	ALLOW PRESSURE TO EQUALIZE.				
22	AHP-13	SCUBA CHARGING	SHUT	CHARGING STATION	
23	SHUT SCUBA CYLINDER MANIFOLD VALVE.				
24	PLACE RESERVE HANDLE IN "UP" POSITION.				
25	OPEN CHARGING YOKE VENT VALVE AND VENT CHARGING HEAD.				
26	REMOVE SCUBA CYLINDER FROM CHARGING YOKE.				

ITEM	COMPONENT	DESCRIPTION	PROCEDURE	LOCATION	CHECK
IF MORE CYLINDERS ARE TO BE CHARGED GO TO ITEM 14 AND REPEAT PROCEDURE.					
27	AHP-1	CHARGING	SHUT	CONTROL PANEL	
28	AHP-3	FLASK 2 SUPPLY	SHUT	CONTROL PANEL	
29	AHP-2	FLASK 1 SUPPLY	SHUT	CONTROL PANEL	
30	AHP-10	FLASK 1 SHUT OFF	SHUT	FLASK	
31	AHP-12	FLASK 2 SHUT OFF	SHUT	FLASK	
32	SLOWLY OPEN CHARGING YOKE SUPPLY VALVE AND VENT SCUBA CHARGING SYSTEM.				
33	SHUT CHARGING YOKE VENT VALVE.				
34	PLACE PROTECTIVE CAP IN CHARGING YOKE.				
35	STOW CHARGING WHIP.				

- END OF PROCEDURE -

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APPENDIX D

ROPER DIVING CART
OPERATIONAL PROCEDURES

OP-4: CART

ITEM	OPERATION	CHECK
STEP 1 PRIOR TO MOVING CART		
1	STOW UMBILICALS.	
2	STOW ALL EQUIPMENT.	
3	SHUT AND SECURE ALL DOORS.	
	CAUTION: TOWING VEHICLE MUST BE APPROVED FOR TRAILER TOWING OF TRAILER 6000 POUNDS OR GREATER.	
4	HITCH CART TO TOWING VEHICLE.	
5	CONNECT WIRING HARNESS BETWEEN CART AND VEHICLE.	
6	CONNECT BOTH SAFETY CHAINS TO TOWING VEHICLE HITCH.	
7	CHECK BRAKE LIGHTS.	
8	CHECK RUNNING LIGHTS.	
9	CHECK CLEARANCE LIGHTS.	
10	CHECK TURNING SIGNALS (LEFT AND RIGHT).	
11	RELEASE TONGUE JACK AND SECURE IN "UP" POSITION.	
12	SECURE BOTH REAR JACKS IN "UP" POSITION.	

ITEM	OPERATION	CHECK
13	REMOVE WHEEL CHOCKS AND STOW.	
STEP 2 SECURING OF ELECTRICAL SYSTEM		
14	PLACE CIRCUIT BREAKER IN "OFF" POSITION.	
15	SECURE POWER SOURCE.	
16	DISCONNECT POWER CABLE.	
17	STOW POWER CABLE.	
18	DISCONNECT AND STOW GROUND STRAP.	
STEP 3 CART SET-UP		
19	POSITION CART TO BE CLEAR OF ANY OBSTRUCTIONS, AND CHECK THAT AREA BETWEEN CART AND DIVE SITE IS CLEAR OF ALL OBSTACLES AND TRAFFIC.	
20	PLACE CART IN CLOSE PROXIMITY TO 120 VAC ELECTRICAL SOURCE IF REQUIRED.	
21	PLACE WHEEL CHOCKS UNDER WHEELS TO SECURE CART IN BOTH FORWARD AND AFT DIRECTIONS.	
22	DISCONNECT ELECTRICAL HARNESS BETWEEN CART AND VEHICLE.	
23	DISCONNECT SAFETY CHAINS FROM VEHICLE.	
24	RELEASE CART HITCH SAFETY LATCH.	
25	USING TONGUE JACK LIFT FRONT END OF CART TILL THE CART CAN BE DISCONNECTED FROM TOWING VEHICLE.	

ITEM	OPERATION	CHECK
26	DISCONNECT CART FROM TOWING VEHICLE.	
27	USING TONGUE JACK, LEVEL CART.	
28	USING TWO REAR JACKS, LIFT CART UNTIL A SMALL PORTION OF THE CART WEIGHT IS REMOVED FROM THE WHEELS AND THE CART IS FIXED IN A STATIONARY POSITION.	
STEP 4 ELECTRICAL SYSTEM PRE-CHECK		
NOTE: A POWER SOURCE OF 120 VAC, SINGLE PHASE WITH 3RD WIRE GROUND IS REQUIRED TO POWER THE ROPER CARTS ELECTRICAL SYSTEM.		
29	PLACE CIRCUIT BREAKER IN "OFF" POSITION.	
30	CHECK GROUND STRAP CONNECTED TO CART.	
31	CONNECT GROUND STRAP TO METAL GROUND ON PIER OR SHIP.	
32	INTERFACE POWER CABLE TO POWER SOURCE.	
33	ENERGIZE POWER SOURCE.	
34	PLACE CIRCUIT BREAKER IN "ON" POSITION.	
35	PUSH TEST BUTTON OF GROUND FAULT INTERRUPTER (GFI) RECEPTACLE.	
WARNING: IF GFI DOES NOT DISCONNECT RECEPTACLE PLACE CIRCUIT BREAKER IN "OFF" POSITION AND NOTIFY DIVING SUPERVISOR.		
36	RESET GFI RECEPTACLE.	
- END OF PROCEDURE -		

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APPENDIX E

ROPER DIVING CART
EMERGENCY PROCEDURES

EP-1: CHARGING HOSE FAILURE

ITEM	COMPONENT	DESCRIPTION	PROCEDURE	LOCATION	CHECK
1	AHP-1	CHARGING	SHUT	CONTROL PANEL	
2	SHUT AIR SOURCE STOP VALVE.				
3	NOTIFY DIVING SUPERVISOR.				

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APPENDIX F

ROPER DIVING CART
EMERGENCY PROCEDURES

EP-2: LOSS OF PRIMARY HIGH PRESSURE AIR SUPPLIES

ITEM	COMPONENT	DESCRIPTION	PROCEDURE	LOCATION	CHECK
1	AHP-2	FLASK 1 SUPPLY	SHUT	CONTROL PANEL	
2	AHP-3	FLASK 2 SUPPLY	SHUT	CONTROL PANEL	
3	AHP-4	EMERGENCY FLASK SUPPLY	OPEN	CONTROL PANEL	
4	NOTIFY DIVING SUPERVISOR.				
5	ABORT DIVE.				
6	REMOVE "STANDBY" AND REPLACE WITH "IN-USE" ON FOLLOWING VALVE: AHP-4.				
7	REMOVE "IN-USE" AND REPLACE WITH "EMPTY" ON FOLLOWING VALVES: AHP-2 AND AHP-3.				

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APPENDIX G

ROPER DIVING CART
EMERGENCY PROCEDURES

EP-3: PRIMARY AIR REDUCER FAILS

ITEM	COMPONENT	DESCRIPTION	PROCEDURE	LOCATION	CHECK
SECURE "IN-USE" REDUCER BRING "STANDBY" REDUCER ON LINE.					
1		"IN-USE" REDUCER INLET	SHUT	CONTROL PANEL	
2		"STANDBY" REDUCER INLET	OPEN	CONTROL PANEL	
3	NOTIFY DIVING SUPERVISOR.				
4	ABORT DIVE.				
5	TAG "IN-USE" REDUCER INLET "OOC".				
6	TAG "STANDBY" REDUCER "IN-USE".				

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APPENDIX H

ROPER DIVING CART
EMERGENCY PROCEDURES

EP-4: SECONDARY AIR REDUCER FAILS

ITEM	COMPONENT	DESCRIPTION	PROCEDURE	LOCATION	CHECK
1	AHP-7	REDUCER 1 INLET	SHUT	CONTROL PANEL	
2	AHP-8	REDUCER 2 INLET	SHUT	CONTROL PANEL	
WARNING: 200 PSIG MAXIMUM MANIFOLD PRESSURE					
SLOWLY OPEN THE BYPASS VALVE (AHP-9) TO REGULATE OVERBOTTOM PRESSURE.					
3	AHP-9	REGULATOR BYPASS	OPEN SLOWLY	CONTROL PANEL	
4	NOTIFY DIVING SUPERVISOR.				
5	ABORT DIVE.				
6	PLACE "OOC" TAGS ON AHP-7 AND AHP-8.				
7	REMOVE "STANDBY" AND REPLACE WITH "IN-USE" ON AHP-9.				